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Catch Basin Sediment Field Sampling Plan (Split Sampling Between Rainier Commons, Seattle Public Utility and King County)

Former Rainier Brewery Property
3100 Airport Way South
Seattle, Washington
King County

Prepared for:

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Former Rainier Brewery Property

1.0 Site Background

The former Rainier Brewery property is an approximate 4.57-acre parcel located at 3100, Airport Way South, Seattle, WA (the, "Site"). The Site is bound between South Stevens Street to the north, by South Horton Street to the south, by Interstate-5 to the east and Airport Way South to the west. Rainier Commons, LLC (the, "Rainier") owns the Site, which is operated by Ariel Development, Inc. (the, "Ariel"). One-third of the Site is leased to Tully's Coffee. Tully's roasts, grinds, packages, distributes coffee and operates its corporate headquarters on the premises.

The Site was initially developed in the late 1800s as a brewery and functioned in a similar capacity until 1996. The Site has been owned by several entities since its initial development. Separate phases of Site redevelopment has occurred throughout its history. The Site is currently being redeveloped into community mixed use, including but not limited to, residential, commercial and retail space.

Farallon Consulting, Inc. (the, "Farallon") conducted a Phase I Environmental Site Assessment on April 14, 2004. Farallon reported, from their Site reconnaissance, nine (9) pad-mounted electrical transformers at various locations throughout the Site. Farallon also observed oil staining at floor drains adjacent to transformer vaults within several of the buildings and adjacent to abandoned equipment. They did not identify the transformer locations and associated vaults or drains as a Recognized Environmental Condition. Ariel states all of the existing onsite transformers are non-PCB containing.

On October 12, 2005 the City of Seattle's Public Utilities Department (the, "SPU") conducted a stormwater pollution prevention inspection at the Former Rainier Brewery property. Preliminary analytical data from the sediment sampling event at the Site showed concentrations of PCBs (up to 2,200 mg/kg) in the sediment collected from the following locations: the breezeway trench drain, the catch basins in the tank farm area, and two catch basins in the southwest parking lot adjacent to the building and north of the loading dock. Due to the elevated concentrations of PCBs in the sediments, the SPU directed Ariel to employ a consultant/contractor to assist in proper disposal of the material according to appropriate state and federal regulations. They also, directed Ariel to clean all outdoor inlets/trench drains/catch basins/pipes on its property. The SPU recommended additional sampling and analysis of the materials in subject structures to ensure adequate disposal methods are employed. Ariel received the SPU's Corrective Action Letter dated November 22, 2005 directing Ariel to cleanup the affected Site sediments within 30-days.

Ariel received another SPU letter dated January 6, 2006 regarding "Follow-up to Site Meeting on December 12, 2005" which included an extension of their original request to have Ariel cleanup the Site within 30-days. Ariel formally notified the Washington State Department of Ecology (Ecology) about the presence of PCB concentrations in their catch basin sediments during a meeting between Ecology (Dan Cargill) and Ariel (Eitan Alon and its consultant Conrad Vernon of VEI) on January 24, 2006. Ariel agreed to meet the following SPU required compliance contingencies:

- Meeting the content of the SPU's corrective action letter dated November 22, 2005,
- Hiring of a consultant that is experienced in PCB remediation and disposal,
- Jet-cleaning of all lines connecting catch basins (with PCBs in the sediments) to remove any residual contaminated sediment in the lines,
- Notifying the Department of Ecology of the finding of significant concentrations of PCBs at your site as required by law,
- Keeping SPU apprised of ongoing work at the site in a timely manner,
- Showing continuing forward progress with the cleanup, and
- Meeting with SPU on a quarterly basis to re-evaluate the situation. Quarterly meetings commencing in early March 2006.

During Ariel's January 24, 2006 meeting with Ecology, the SPU's catch basin sediment sampling results and Ecology's regulatory approach for the ultimate cleanup of the Site sediments were discussed and agreed. The following items (in order of priority) were identified:

- Provide Methodology Plan for identifying underground subject pipes,
- Identify underground subject pipes with a dye study or other equivalent means to Ecology's satisfaction,
- Provide an as-built drawing of subject underground pipes including inlet points, catch basins, manholes, etc.
- Provide Field work Plans, i.e., Field Sampling Plan, Data Quality Objectives Plan, Quality Assurance/Quality Control (QA/QC) Plan and Health & Safety Plan,
- Collect manhole and catch basin sediment samples, analyze samples, report analytical results,
- Provide a Remedial Action Plan to cleanup the Site sediments in pipes and collection points (i.e., cleanup the catch basin and manhole sediments, as well as jet clean the pipes), and
- Implement the Remedial Action Plan.

Ariel has located and identified subject underground pipes on the Site and has provided an as-built drawing presenting the aforementioned utilities (Figure 1). The Field Work Plans, i.e., Field Sampling Plan, Data Quality Objective Plan, Quality Assurance/Quality Control Plan and the Health & Safety Plan are the next step in complying with the overseeing regulatory authorities requirements.

Sediment Analytical Results:

SPU sampled six (6) sediment sample points for the presence of PCBs at locations discussed above. The analytical results from each location are BNSF CB1-17 mg/kg, BNSF CB2-23 mg/kg, CB 14-175 mg/kg, CB 8-1,340 mg/kg, composite of CB1 through CB6-19.8 mg/kg and CB12-2,200 mg/kg (Figure 1).

On October 4, 2007 KC's Bruce Tiffany and Arnaud Girard, SPU's Beth Schmoyer, VEI's Conrad Vernon, and Rainer Commons' Eitan Alon and John Jack met to discuss potential catch basin sediment containing polychlorinated biphenyl (the, "PCB") that may potentially be discharged from the Site to the Duwamish waterway and wastewater treatment facility located at the Magnolia, Washington treatment facility via KC and SPU storm drains and combined sewer overflows.

VEI compared past SPU PCB analytical results from its October 12, 2005 stormwater pollution prevention catch basin inspection and VEI's catch basin analytical results collected in June 2006 at the Site. VEI showed the concentrations of PCB analytical results, found in the Site catch basin sediments, had decreased from SPU's highest sample concentration of 2,200 mg/kg located in catch basin CB 12 to VEI's CB 12 sediment PCB sample result concentration of non-detect (at a Method Reporting Limit of 0.20 mg/kg) by Advanced Analytical laboratory located in Redmond, WA. SPU and VEI catch basin analytical result trends are presented below.

SPU October 2005 Rainier Commons Catch Basin Sediment Analytical Results (PCB A1254)	**VEI June 2006 Rainier Commons Catch Basin Sediment Analytical Results (PCB A1254)**
BNSF CB-1: 17 mg/kg	BNSF CB-1: 4.3 mg/kg
BNSF CB-2: 23 mg/kg	BNSF CB-2: Non-Detect (ND)
CB-14: 175 mg/kg	CB-14: 0.51 mg/kg
CB-8: 1,340	CB-8: 3.2 mg/kg
CB-1 through CB-6 (composite): 19.8 mg/kg	CB-1: 0.54 mg/kg; CB-2 through CB-6: ND
CB-12: 2,200 mg/kg	CB-12: ND

In an effort to determine whether the PCB source was a result of paint chips released from the facility during painting operations, VEI also collected a paint chip sample. The sample analytical result showed the paint contains 2,300 mg/kg PCB A1254. Based on the paint sample analytical result compared to SPU's catch basin sediment highest PCB analytical result of 2,200 mg/kg, it is highly feasible the paint chips are the source of catch basin sediment impact that may be a result of paint chips migrating from paint chip removal activities to the catch basins during surface run-off precipitation events. Remaining PCB paint on the exterior of the building has been encapsulated through the application of new paint. Moreover, Rainier Commons implemented its PCB Paint O&M Plan in its effort to prevent any future release.

It is Rainier Commons' position that the paint chips are no longer present above regulatory concentration limits in the Site catch basin sediments as the analytical trends show over time. It is Rainier Commons' understanding that KC and SPU are identifying immediately adjacent and hydraulically down gradient catch basin sample locations to the Site. Further, KC and SPU will sample the sediments and storm/wastewater of those identified locations and provide sufficient notice (preferably 10-business days) to VEI before KC's and SPU's sampling event so VEI may be present during split sampling activities, chain of custody and transportation to the selected analytical laboratory(s). Prior to the sampling event VEI requested a copy of KC's and SPU's Field Sampling Plan and/or any other field work plan, i.e., QA/QC Plan, SOPs, so it can incorporate them into VEI's field work plans for split sampling (SPU SAP attached).

Chemical(s)-of-concern (PCBs) will be compared to Ecology's MTCA Method A cleanup levels of 1.0 mg/kg in a soil matrix. Guidance promulgated under federal statutes 40 CFR 761 is also referenced.

This Field Sampling Plan is prepared for on-site sampling activities. The plan includes:

- Sampling objectives
- Sample location and frequency
- Sample Designation
- Sampling equipment and procedures
- Sample handling and analysis

2.0 Sampling Objectives

The sampling objectives, for this sampling event, are to identify potential off-site migration of PCBs and their respective concentrations in sediments at SPU identified down gradient and immediately adjacent off-site catch basin locations. Analytical results will be used to determine future sediment collection and analysis, as well as, remediation points of cleanup compliance.

Another objective is to demonstrate data identification; decision inputs, decision rule development, decision error limits and design optimization are addressed.

3.0 Sample Location and Frequency

Figure 1 shows the proposed sediment grab/composite sample locations (these are numbered catch basins). SPU has identified three (3) hydraulically down gradient, immediately adjacent and off-site catch basin sample locations, i.e., a Tully Line Catch Basin, a South Stevens Catch Basin and an Airport Way South Catch Basin. The catch basins and trench drains collect surface drainage and convey it to the storm drain lines (pipes). Selection of these locations assumes the sediment grab/composite sample locations cover the impacted area(s) of the Site underground stormwater utilities and the samples are at locations hydraulically down-gradient in the drainage system, immediately adjacent and will therefore, be representative of Site hydraulically up-gradient underground utility conditions.

Sediment samples will be collected and analyzed from each of three (3) catch basin locations during this sampling event as grab/composite sediment samples (Section 5) and in-line sampling methodology as described in the SPU Sampling and Analysis Plan (SAP) (Appendix A).

4.0 Sample Designation

Collected sediment samples will be designated as shown in Table 1. Sampling guidelines are provided in Table 2. The sampling point locations include end of pipe collection of Site stormwater system at each of three (3) catch basins. Sediment grab/composite samples will be collected for one chemical-of-concern, i.e., PCBs at each sample location.

One (1) duplicate from one (1) catch basin will be collected for quality control purposes.

5.0 Sample Equipment, Procedures and Handling

Vernon Environmental, Inc. (VEI) will collect split sediment grab/composite and sediment in-line samples at the locations identified.

EPA prescribed method protocols regarding sample collection, cross contamination prevention, sample preservation, sample container type, sample holding temperature, and holding times will be followed (Table 2).

Sediment Sample Collection

Gloves will be worn at all times while collecting sediment samples. Descriptions of field observations (including oil sheens and potential contributing activities) and sample characteristics (odor, amount and type of particles being removed, size description, color) will be included in field notes recorded during sample collection.

Catch Basin Sediment
Catch-basin end of pipe sediment samples will be collected using stainless steel spoons and long-handled scoops or soil coring devices. Samples will be collected from end of pipe sediment accumulated in the catch basin sump or in-line structure during pipe jetting operations. Individual aliquots will be collected from the end of pipe sediments placed in a stainless steel bowl, and thoroughly mixed. Any particles greater than 2 centimeter in size will be removed from the sample and discarded. After mixing, three (3) - 250gram aliquot samples (split samples collected for SPU, KC and Rainier Commons) will be removed and placed into pre-cleaned sample containers provided by the analytical laboratory. Samples will be placed in a cooler and stored on ice until delivered to the analytical laboratory. Three (3) split samples will also be collected from decanted vactor truck sediments (please reference the Data Quality Objective Plan regarding representative sediment sample collection and analysis not reflecting Site conditions).

Equipment Decontamination

All sampling equipment including stainless-steel materials will be decontaminated prior to each sampling event. The following decontamination procedures will be followed after every sampling event:

Stainless-Steel Scoop and Mixing Bowl

- Phosphate-free detergent wash and tap water rinse
- Reagent-grade water rinse
- Ultra-pure methanol rinse
- Air dry
- Wrapped in new aluminum foil and bagged in plastic.

After the decontamination procedures have been completed, the sampling equipment will be capped or sealed with new aluminum foil and the sampling device will be protected and kept clean.

Each sample will be clearly marked with the date and time of sample collection, sample collection technician's name, unique sample identification, preservative used and analysis to be performed. Each sample will be sealed with chain-of-custody tape. Each sample cooler will contain blue ice (or equivalent) to keep the temperature below 40 degrees Fahrenheit. Each sample cooler will be chain-of-custody sealed and a chain-of-custody form will be completed in triplicate and placed in the cooler prior to sealing and shipment.

6.0 Sample Analysis

Collected sediment sample analyses are presented in Table 1.

Tables and Figures

TABLE 1

SAMPLE DESIGNATION

Collected Analytical Samples				
Rainier Commons, LLC-Ariel Development Former Rainier Brewery Property 3100 Airport Way South, Seattle, WA			Sample Date:	Week of 1/7/08
Matrix	**Parameters**	**Method**	**TAT (days)**	**Number of Samples per Catch Basin Location**
Hydraulically down Gradient Catch Basin Sediments	PCBs	EPA 8082	3	1*
Duplicate	PCBs	EPA 8082	1	*

**Each sample location will consist of 1-sample collected as a grab composite sediment sample from a five- (5) point matrix (1-center and 4-corners of each catch basin).*

**Duplicate sample to be collected at 1-catch basin*

TABLE 2

SAMPLING GUIDELINES

Catch Basin Sediment Sampling Guide - Former Rainier Brewery					
Analysis	Specific Method	Container	Preservation	Hold (days)	Amount Needed
Polychlorinated Biphenyls by EPA Method 8082 in Soil					
8082 PCB Only	EPA 8082	Glass jar w/PTFE seal	Store cool at 4°C	14	250 grams
Polychlorinated Biphenyls by EPA Method 8082 in Wipe					
8082 PCB Only	EPA 8082	Glass jar w/PTFE seal	Store sealed at STP	14	One wipe in Hexane

Attachment

Data Quality Objectives, QA/QC Plan, Conceptual Site Model

SAMPLING AND ANALYSIS PLAN

Diagonal Avenue South Drainage Basin Pollutant Source Investigation

Prepared for

Seattle Public Utilities

June 2003

SAMPLING AND ANALYSIS PLAN

Diagonal Avenue South Drainage Basin Pollutant Source Investigation

Prepared for

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June 2003

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Introduction

Seattle Public Utilities (SPU) is partnering with the King County Industrial Waste, Public Health, and Hazardous Waste Programs to conduct pollutant source control activities for the Lower Duwamish Waterway Superfund investigation. The site was placed on the National Priorities list in 2001 due to the presence of contaminants in the waterway sediments, particularly polychlorinated biphenyls (PCBs), phthalate esters and other semi-volatile organic compounds (SVOCs), and metals (arsenic, copper, lead, mercury, tributyltin). A large part of the source control program is a business inspection effort to identify potential ongoing sources and to work with businesses in the area to reduce the amount of pollutants currently discharged to the waterway via storm drains and combined sewer overflows (CSOs). Understanding and controlling ongoing sources of contaminants to the river is very important to minimize the potential for sediment recontamination following cleanup.

To support the business inspection efforts, SPU will conduct source tracing and identification investigations in the study area. This information will be used to prioritize business inspections in specific areas where the contaminants of concern (COC) for the waterway sediments are found in the SPU drainage system. In addition, source source sampling information will be used to confirm the presence/absence of COCs at individual sites within the SPU collection system that is tributary to the lower Duwamish Waterway. The following types of samples will be collected as part of this effort:

- Onsite catch basin sediment
- Right-of-way catch basin sediment
- Inline manhole sediment (where available in sufficient quantity for analysis)
- Inline suspended sediment.

The Diagonal/Duwamish area is the first of seven early action sites identified for the Duwamish Waterway (Windward 2003). Early action sites are areas that have been recommended for cleanup on an accelerated scheduled because they pose a relatively higher risk to human health or the environment. Contaminants that exceed the sediment management standards in the Diagonal/Duwamish early action area include include PCBs, bis(2-ethylhexyl) phthalate (BEP), butylbenzyl phthalate (BBP), carcinogenic PAHs, and other semi-volatile organic compounds (SVOC), arsenic, mercury, and zinc. Cleanup of contaminated waterway sediment was completed in March 2004.

In 2002, SPU began removing accumulated sediment from the lower portion of the Diagonal Ave S CSO/SD system. SPU crews cleaned the two laterals (approximately 2,800 lineal feet) and in 2003, a contractor began work on the mainline and the S Dakota St lateral. Approximately 498 CY of sediment was removed from the Diagonal system in 2002-2003 and transported to a nearby cement plant, where it was reused in the cement manufacturing process.

SPU plans to clean the remaining 600 feet in the S Dakota lateral in 2004. Work is scheduled to begin in July and be performed by SPU crews. Sediment removed from the drain will be dewatered at an SPU vactor decant facility and disposed by SPU's solid waste disposal contractor.

The Diagonal Ave S CSO/SD, which discharges directly to the early action site, is the largest storm drain in the Seattle storm drainage system. It is referred to as a CSO/SD because it receives stormwater runoff from the surrounding area and also discharges combined sewer overflows from both the King County interceptor system and the local Seattle combined sewer system.

This report describes the sampling activities that will be conducted by SPU to assist in identifying ongoing sources of contaminants in the Diagonal Ave S CSO/SD system. It is intended to act as a template for source sampling to be conducted in other early action sites. Included in this report are a site description and summary of historic studies in the project area. The project organization and schedule is briefly presented, and the project sampling design is described. Data quality objectives, field and laboratory procedures, and data quality assessment and data management procedures are also presented. This plan has been prepared according to guidelines developed by the Washington Department of Ecology (Ecology 2001).

Project Description

The Diagonal Avenue South Drainage Basin Pollutant Source Investigation will apply a targeted approach to identify sources of contaminants to the waterway. Implementation of this project will continue over several years. The approach for the Diagonal basin study will be applied to other early action sites in the Lower Duwamish Superfund drainage area to support source control activities. As mentioned earlier, SPU is working with King County to identify and control potential sources of contaminants to the Duwamish Waterway. A preliminary plan for coordinating inspection and enforcement activities at businesses operating within the basin has been developed and presented to the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology).

The goals of the project are to identify sources of pollutants to the waterway sediments from stormwater discharges and to evaluate the effectiveness of source control methods using high-quality data collected by SPU as part of its pollutant source investigation efforts in the Diagonal Ave S CSO/SD system. Sediment and stormwater samples will be collected from various sites in the basin for analysis of the following pollutants of concern: arsenic, mercury, polychlorinated biphenyls (PCBs), and phthalates. Sediment and stormwater samples will also be analyzed for additional common stormwater metals (i.e., copper, lead and zinc) and organics (i.e., polycyclic aromatic hydrocarbons). To facilitate the evaluation of analytical results, sediment samples will also be analyzed for total organic carbon (TOC) and grain size, and stormwater samples will also be analyzed for total suspended solids and hardness.

The information obtained will allow SPU to focus business inspections on high priority areas and assist in identifying potential contaminant sources in the Diagonal drainage basin. Data may also be used to assist King County in the development of a near-field model for the nearby combined sewer overflow (CSO) outfalls.

Site Description

The Diagonal Ave S CSO/SD basin discharges into the lower Duwamish Waterway via an outlet structure that contains two 12-foot by 9-foot openings located at S Oregon St at approximately river mile 0.5 (Figures 1 and 2). The Diagonal storm drain basin encompasses approximately 2,600 acres that includes a significant portion of the south Seattle light industrial area, commercial areas along Rainier Ave S, and residential areas along Beacon Hill. Approximately 3.5 miles of I-5 also drain to the Diagonal system. The average annual discharge from the Diagonal drainage system has been estimated at approximately 1,200 million gallons per year (King County et al. 2001). The Hanford (stormwater/CSO conveyance) tunnel connects the western and eastern parts of the basin. The Diagonal outfall also receives combined sewer overflows from the City of Seattle (approximately 624 acres) and King County combined sewer systems (approximately 4,900 acres). Seattle Public Utilities operates and maintains six separate overflows and King County operates one overflow to the Diagonal drainage system (see Figure

2). The total Seattle CSO discharge rate is estimated to range from 0.6 to 5 million gallons per year based on monitoring records for 1998 through 2001. The King County CSO discharge rate has been estimated at about 65 million gallons per year (King County et al. 2001).

The Diagonal drainage system is tidally-influenced throughout a large portion of the lower drainage system. Based on mean higher high water (MHHW) data and existing information from SPU's geographic information system (GIS) database, tidal influence within the drainage system extends as far upstream as Airport Way South.

Previous Studies

Several studies and reports have described sediment and stormwater conditions in the Diagonal storm drain system, most often in the context of potential impacts to the Duwamish Waterway. These studies are briefly summarized below in terms of the contaminants of concern for the current project. For reference, sediment and water quality standards for contaminants of concern and other select parameters are presented in Table 1.

Table 1. Marine sediment and water quality criteria for selected parameters.

	Sediment [a]	Water [b]
Arsenic	57 mg/kg DW	36.0 µg/L
Copper	390 mg/kg DW	3.1 µg/L
Mercury	0.41 mg/kg DW	0.025 µg/L
Lead	450 mg/kg DW	8.1 µg/L
Zinc	410 mg/kg DW	81.0 µg/L
Total PCBs	12 mg/kg OC	0.03 µg/L
Bis(2-ethylhexyl) phthalate	47 mg/kg OC	2.2 µg/L
Butylbenzyl phthalate	4.9 mg/kg OC	1,900 µg/L
Dimethyl phthalate	53 mg/kg OC	1,100,000 µg/L
Di-n-butyl phthalate	220 mg/kg OC	4,500 µg/L

[a] Sediment quality standard (SQS) for marine sediment (WAC 173-204). Criteria are based on dry weight (DW) for metals and organic carbon (OC) for organics.
[b] Marine water chronic criteria for metals and total polychlorinated biphenyls (PCBs) (WAC 173-201A). Human health criteria for consumption of organisms only for phthalates (EPA 2002b).

Seattle Public Utilities Diagonal Storm Drain Cleaning Preparation

Tetra Tech (2002) collected sediment and decant water samples in January and February 2002 to characterize the storm drain sediment prior to cleaning the Diagonal Ave S CSO/SD. One sediment sample was collected from each of six locations on the main line and five locations on lateral (tributary) lines in the lower part of the basin (downstream of 4th Ave S). The sediment samples were analyzed for metals, total petroleum hydrocarbons, semivolatile organic compounds (SVOCs), total organic carbon (TOC), pesticides/PCBs, and grain size. However, samples collected from the outfall were analyzed only for metals due to insufficient sediment volume (Tetra Tech 2002).

Arsenic and mercury were not detected in sediment samples at levels above the respective practical quantitation limit (PQL) or Washington State sediment quality standard (SQS) (WAC 173-204). Concentrations of bis(2-ethylhexyl) phthalate exceeded the SQS (47 µg/mg organic carbon) at nine of ten locations. No other phthalate esters were detected above the PQL or SQS. None of the samples exhibited PCB concentrations above the PQL, but PCBs were detected below the PQL at three lateral line locations, with one location exceeding the SQS (12 mg/kg) for Aroclor 1254, Aroclor 1260, and total PCBs.

King County Stormwater Data

In 1995, King County collected stormwater samples during several storm events from two locations within the Diagonal storm drain system; one on a lateral drain line (three storms) and one on the main line (seven storms). The mainline storm drain is located at S Hinds St and 6th Ave S, and the lateral line storm drain is located at S Horton St and 8th Ave S. The samples were analyzed for conventionals, metals, semi-volatile organic compounds, pesticides, PCBs, and volatile organic compounds, including the contaminants of concern for the Diagonal basin project (King County 1995).

Arsenic concentrations in the three lateral line samples averaged 2.49 µg/L and ranged from 1.60 to 2.83 µg/L. Arsenic levels in the seven main line samples averaged 2.86 µg/L and ranged from 1.9 to 3.71 µg/L. All arsenic concentrations were below the Washington State marine acute (69.0 µg/L) and chronic (36.0 µg/L) water quality criteria (WAC 173-201a). Mercury was detected in only one sample from the main line storm drain (South Horton Street). The mercury level (0.32 µg/L) in that sample exceeded the Washington State marine chronic criterion (0.025 µg/L) (WAC 173-201a), but not the acute criterion (1.8 µg/L).

Four phthalate compounds (bis[2-ethylhexyl] phthalate, butylbenzyl phthalate, di-n-butyl phthalate, and dimethyl phthalate) were detected in stormwater samples collected from both storm drain locations. Although aquatic toxicity criteria have not been established for any phthalate compound, EPA (2002) has established water quality criteria for phthalates to protect human health from consumption of aquatic organisms (see Table 1). None of the phthalate results exceeded the human health criteria for bis(2-ethylhexyl) phthalate (0.0022 mg/L), butylbenzyl phthalate (1.9 mg/L), di-n-butyl phthalate (4.5 mg/L), or dimethyl phthalate (1,100 mg/L). PCBs were not detected in any stormwater sample and the detection limits were less than the Washington State marine chronic criterion (0.03 µg/L) (WAC 173-201a).

Pesticides and PCBs were not detected in any of the samples; detection limits ranged from 0.02 to 0.5 ug/L. Volatile organic compounds (VOC) were infrequently detected. The following four VOC were detected in at least one sample: 1,1,1-trichloroethane, acetone, tetrachloroethylene, and trifluorotoluene.

Elliott Bay/Duwamish Restoration Program

Between August 1994 and September 1996, King County Department of Natural Resources collected sediment samples in the Duwamish Waterway near the Diagonal outfall as part of the Elliott Bay/Duwamish Restoration Program (King County et al. 2001). The purpose of the sampling effort was to delineate the extent and magnitude of sediment contamination in the vicinity of four outfalls (Diagonal Ave S CSO/SD, Diagonal Ave S SD, old wastewater treatment plant outfall, and the King County Duwamish pump station overflow), and to recommend the size of a cleanup area.

Surface sediment samples were collected at 34 stations located in the vicinity of the Diagonal outfall (i.e., in the North Inshore Area located inshore of the dredged navigation channel and within 400 feet upstream and 800 feet downstream of the Diagonal outfall). Contaminant levels were compared to sediment quality standards (SQS) and cleanup screening levels (CSL) (Chapter 173-204 WAC). Based on those comparisons, contaminants of concern were identified as:

- PCBs (24 SQS exceedances, 6 CSL exceedances)
- Mercury (5 SQS exceedances, 2 CSL exceedances)
- Bis(2-ethylhexyl) phthalate (9 SQS exceedances, 27 CSL exceedances)
- Butyl benzyl phthalate (23 SQS exceedances, 3 CSL exceedances).

Compounds were also evaluated for human health risks based on contaminant levels in fish tissue samples collected near the two outfalls (PSAMP 1992 as referenced in King County et al. 2001). Contaminants of concern for human health risks were identified as PCBs, total DDT, and arsenic.

As part of the discussion of potential contaminant sources in the study area, results were presented for sediment samples collected from within the Diagonal storm drain system by the City of Seattle Drainage and Wastewater Utility in 1994. Results indicated no SQS exceedances for metals. However, concentrations of bis(2-ethylhexyl) phthalate exceeded the CSL criterion (78 mg/kg organic carbon) in three of four samples.

Project Organization and Schedule

SPU will collect all sediment samples. SPU will install suspended sediment traps in the drainage line at six locations. The sediment samples will be analyzed by Analytical Resources, Inc. (ARI), Brooks Rand, Ltd., and Am Test Laboratories.

SPU will deliver all samples to ARI for analysis. ARI will conduct all analyses with the exception that Am Test Laboratories will analyze the sediment samples for grain size.

Project personnel and quality assurance responsibilities are listed below:

Seattle Public Utilities (SPU) 700 5th Ave, 44th floor Seattle, WA 98104	Mailing Address: 700 Fifth Avenue, Suite 4900 PO Box 34018 Seattle, WA 98104-4018	
Project Manager/QA Officer:	Beth Schmoyer Email: beth.schmoyer@seattle.gov	(206) 386-1199
Field Lead	Mike Hinson Email: michael.hinson@seattle.gov	(206) 733-9134
Analytical Resources, Inc. (ARI) 4611 South 134th Place Tukwila, WA 98168-3240		
Project Manager:	Mark Harris Email: mark@arilabs.com	(206) 621-6490
Am Test Laboratories 14603 NE 87th Street Redmond, WA 98052		
Project Manager:	Kathy Fugiel Email: (b) (6)	(425) 885-1664

The project schedule is presented by task in Table 2 for the first 2 years of the study. The task schedule may change for Year 2 and subsequent years depending on the Year 1 results.

Table 2. Schedule of the Diagonal Avenue South drainage basin pollutant source investigation.

Task	Schedule
Catch basin sediment sampling	Begin August 2003 and continue for duration of source tracing effort
In-line sediment grab sampling	April 2003 –September 2003
In-line sediment trap sampling	Begin 2003. Install traps for 6-month periods (September–February and March – August). Continue for duration of source tracing effort
Project report	Results to be included in biannual source control reports to EPA and Ecology

Sampling Design

Three types of sediment sampling will be employed to maximize coverage of the Diagonal drainage basin and to gather information on the extent and location of contaminants. In addition, stormwater samples will be collected near the outfall into the Duwamish Waterway with a flow-weighted, automated sampler to evaluate overall contaminant levels in the basin drainage. Each of these four study components are described below, followed by the sample analysis procedures. Table 3 outlines the sampling design including sample site location, project and quality control sample frequency, and analyses to be performed.

Table 3. Sampling design for each year of the Diagonal drainage basin pollutant source investigation.

Sample Sites	Site ID	Project and Field QC Samples	Analyses
Catch Basin Sediment			
Up to 75 sites to be determined during business inspections	CB#	▪ 1 sediment grab/site (up to 75 samples/year) ▪ 1 field duplicate/20 samples	▪ TOC, grain size ▪ Arsenic, mercury, copper, lead, zinc ▪ PCBs ▪ SVOCs
Sediment Traps[a]			
W of E Marginal Way S	ST1	▪ 1 sediment composite/site	▪ TOC, grain size
Airport Way S south of I90	ST2	▪ 1 field duplicate at 1 of 6 sites	▪ Arsenic, mercury, copper, lead, zinc
S Forest St	ST3		
MLK Jr. Wy	ST4		▪ PCBs
S College St	ST5		▪ SVOCs
S Bush St	ST6		
S Dakota St	ST7		
In-line Sediment[a]			
E Marginal Way S	MH1	▪ 1 sediment grab/site	▪ TOC, grain size
Airport Way S	MH2	▪ 1 field duplicate at 1 of 6 sites	▪ Arsenic, mercury, copper, lead, zinc
S Forest St	MH3		
MLK Jr. Way	MH4		▪ PCBs
S College St	MH5		▪ SVOCs
S Bush Pl	MH6		
S Dakota St	MH7		

a. See Figure 2 for station locations.

Catch Basin Sediment

As part of the business inspection effort, SPU inspectors will collect on-site catch basin sediment samples to confirm the presence or absence of COCs found in the waterway sediments. Samples will be collected if there is evidence of contaminants that might enter the drainage system (i.e., oil sheen, odors, known chemical use, and observed activities that might produce contaminants). Approximately 1,000 businesses will be inspected, with sediment collection occurring at 50 to 75 catch basins. One sediment sample will be collected from each catch basin exhibiting evidence of contamination.

SPU will also collect sediment samples from catch basins located in the public right-of-way to evaluate contributions from roadways. Samples will be collected from a variety of roadways (e.g., residential streets, arterials, and highways) within the Diagonal Ave S basin. Approximately 40 to 50 samples will be collected from the right-of-way.

Sediment Traps

Sediment traps will be installed in storm drains at the following seven locations (see Figure 2):

- ST-1: E Marginal Way S and S Oregon St (Manhole #D056-126).
- ST-2: Airport Way S and West Seattle Bridge, eastbound (Manhole # D057-021).
- ST-3: S Forest St and 8th Ave S (No manhole #)
- ST-4: S Winthrop St and Martin Luther King Jr. Way (Manhole #D052-403).
- ST-5: Rainier Ave S and S College St (Manhole #D052-138)
- ST-6: Rainer Ave S and S Bush St (Manhole #D045-098)
- ST-7: S Dakota St and 6th Ave S (Manhole #D057-090).

Sediment trap samples will be collected in pre-cleaned, one-liter wide mouth Teflon containers. At each sampling location, two sediment traps will be mounted to the wall of the manhole or pipeline just above the base flow level within the storm drain to collect sediment associated with storm flows. Each sediment trap consists of a stainless-steel bracket and housing that holds a Teflon sample container (Figure 3). The sediment traps were fabricated for SPU based on an initial design by Ecology (1996) and modifications by the City of Tacoma (2001).

Sediment traps will be deployed for approximately 6-month intervals. Traps will be installed from September to about February to capture winter storm flows and again from March to August to collect spring-summer storm flows.

In-line Sediments

If possible, sediment that accumulates within the storm drain at the sediment trap will also be sampled. If sufficient sediment is present, SPU staff will collect one in-line sediment sample at each sediment trap location listed above. The in-line sediment samples will be collected during retrieval of the sediment trap samples to allow for the analysis of both samples in the same analytical batch.

Sample Analysis

Sediment samples will be analyzed for the parameters of concern (arsenic, mercury, PCBs and semi-volatile organic compounds, including phthalate esters), as well as other common stormwater pollutants (i.e., copper, lead, zinc, and polycyclic aromatic hydrocarbons). Sediment samples will also be analyzed for grain size and TOC to facilitate the comparison of results to sediment standards (WAC 173-204). If insufficient sediment is collected for any sample, the analyses will be prioritized in the following order: PCBs, SVOCs, arsenic, mercury, copper, lead, zinc, total organic carbon, and grain size. Water samples will also be analyzed for total suspended solids and hardness to facilitate evaluation of the results and comparison to water quality standards (WAC 173-201A). Table 4 presents the analytical methods to be used for this project.

Table 4. Analytical parameters and methods.

Parameter	Method [a]	Type	Sample Container	Holding Time [b]	Preservation
Sediment					
Total organic carbon	415.1	combustion	125 mL HDPE [c]	6 months	Cool to 4°C
Grain size	PSEP	sieve	250 mL HDPE	6 months	Cool to 4°C
Arsenic	6010	ICP	125 mL HDPE [c]	6 months	Cool to 4°C
Mercury	7471	CVAA	125 mL HDPE [c]	28 days	Cool to 4°C
Copper	6010	ICP	125 mL HDPE [c]	6 months	Cool to 4°C
Lead	6010	ICP	125 mL HDPE [c]	6 months	Cool to 4°C
Zinc	6010	ICP	125 mL HDPE [c]	6 months	Cool to 4°C
PCBs	8082	GC-ECD	250 mL glass	14 days; 40 days	Cool to 4°C
SVOCs	8270	GC-MS	250 mL glass	14 days; 40 days	Cool to 4°C

[a] EPA-approved methods in EPA 1983, 1994, and 2002a and in PSEP 1997.
[b] For PCBs and semivolatile organic compounds, holding times are for extraction and analysis of the elutriate.
[c] One container for total organic carbon, arsenic, mercury, copper, lead, and zinc in each sediment sample.
ICP – Inductively-coupled plasmaspectrometer.
CVAA – Cold vapor atomic absorption.
GC-ECD – Gas chromatograph-electron capture detection.
GC-MS – Gas chromatograph-mass spectrometer.
ICP-MS – Inductively coupled plasma-mass spectrometer.
CVAF – Cold vapor atomic fluorescence.
HDPE – High density polyethelene

Data Quality Objectives

The goal of this project is to collect data that will assist in locating sources of stormwater pollutants and help focus agency business inspections on high priority areas in the Diagonal Ave S CSO/SD drainage basin. The sampling activities may also provide input to a near-field sediment recontamination model currently being developed by King County.

Data quality objectives for the laboratory analyses are presented in Table 5 and described in separate sections below. The overall quality control objective is to ensure that data of a known and acceptable quality are collected for this project. A table of the analytical laboratory's control limits is presented in Appendix B.

Table 5. Accuracy, precision, and reporting limit objectives for analytical parameters.

Parameter	Reporting Limit [a]	Accuracy (percent recovery)	Precision (relative percent difference)
Sediment			
Total organic carbon	200 mg/kg	75 – 125%	≤ 20%
Grain size	NA	NA	NA
Arsenic	5.0 mg/kg	75 – 125%	≤ 20%
Mercury	0.05 mg/kg	75 – 125%	≤ 20%
Copper	0.2 mg/kg	75 – 125%	≤ 20%
Lead	2.0 mg/kg	75 – 125%	≤ 20%
Zinc	0.6 mg/kg	75 – 125%	≤ 20%
SVOCs	67 µg/kg [b]	50 – 150%	≤ 50%
PCBs	5 µg/kg	50 – 150%	≤ 50%

[a] Reporting limits for sediments are reported as dry weight.
[b] Reporting limits vary for semivolatile organic compounds; the reporting limit presented is for the phthalate esters.

Accuracy and Bias

Accuracy and bias, the degree to which the analytical results reflect the true value of the sample, will be assessed using analyses of laboratory preparation blanks, matrix spikes, and control standards. Values for blanks will not exceed 2 times the reporting limit. Generally, the percent recovery of matrix spikes will be between 75 and 125 percent for metals (mercury and arsenic) and between approximately 50 and 150 percent for organics (PCBs and semivolatile organic compounds). Matrix spike recovery limits for individual compounds may vary outside these ranges. A table of the analytical laboratory's recovery limits for individual compounds are presented in Appendix B. The percent recovery of control standards will be within control limits reported by the analytical laboratory that are based on historic performance.

The analytical laboratory will implement several steps to increase the accuracy of the PCB analyses. Initially, samples will be extracted and the extracts analyzed for PCBs. If there is background contamination or interference, the extracts will be acid cleaned with sulfuric acid and re-analyzed. If background interference is still apparent, the extract will be cleaned again with potassium permanganate and re-analyzed.

Precision

Precision is a measure of the scatter in the data due to random error caused primarily from sampling and analytical procedures. Precision will be assessed using laboratory duplicates and field duplicates. Laboratory duplicates will be analyzed with every sample batch. Field duplicates will be analyzed at the frequency identified in Table 3.

Two levels of precision for duplicate analyses will be evaluated. The relative percent difference (RPD) between laboratory duplicates will be less than 20 percent for metals and less than 50 percent for organics if both duplicate values are greater than 5 times the reporting limit. The difference between laboratory duplicates will be ±1 times the reporting limit for metals and ±2 times the reporting limit for organics if either duplicate is less than or equal to 5 times the reporting limit. For organic analyses, precision will be determined between the matrix spike and matrix spike duplicate (MSD).

Representativeness

The sampling program is designed to provide samples that reflect pollutant concentrations in stormwater and sediments in the Diagonal drainage basin. Sample representativeness will be ensured by employing consistent and standard sampling procedures (see below). Stormwater samples will be collected as flow-weighted composites using an automatic sampler, flow meter, and conductivity meter to characterize stormwater for the Diagonal drainage system that is not influenced by tides. Equipment decontamination and sample handling procedures will be employed to prevent contamination of sediment and stormwater samples.

Completeness

A minimum of 95 percent of the samples submitted to the laboratory will be judged valid. It is anticipated that all samples will be collected. An equipment checklist will be used to prevent loss of data resulting from missing containers or inoperable instruments prior to embarking on field sampling trips. Automatic recording equipment will be checked regularly to ensure that it is in good working order.

Comparability

Data comparability will be ensured through the application of standard sampling procedures, analytical methods, units of measurement, and detection limits. The results will be tabulated in standard spreadsheets for comparison with threshold limits and background data.

Field Procedures

This section describes field procedures that will be utilized to ensure that samples are collected in a consistent manner and are representative of the matrix being sampled, and the data will be comparable to data collected by other existing and future monitoring programs. Procedures are described for collecting stormwater and sediment samples, decontaminating sampling equipment, and recording field measurements and conditions. Requirements for sample containers and preservation, sample identification, and field quality control procedures are also described. Sampling procedures will generally follow *Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound* (PSEP 1997).

Sediment Sample Collection

Sediment samples will be collected following PSEP (1997) guidelines for sediment sample collection. Gloves will be worn at all times while collecting sediment samples. Descriptions of field observations (including oil sheens and potential contributing activities) and sample characteristics (odor, amount and type of particles being removed, size description, color) will be included in field notes recorded during sample collection. All sediment collection equipment will be decontaminated following PSEP guidelines (see below).

Catch Basin and In-Line Sediment

Catch-basin and in-line sediment samples will be collected using stainless steel spoons and long-handled scoops or soil coring devices. Samples will be collected from the top 3-4 inches of sediment accumulated in the catch basin sump or in-line structure. Individual aliquots will be collected from at least three locations in the sump/structure, placed in a stainless steel bowl, and thoroughly mixed. Any particles greater than 2 centimeter in size will be removed from the sample and discarded. After mixing, samples will be placed into pre-cleaned sample containers provided by the analytical laboratory. Samples will be placed in a cooler and stored on ice until delivered to the analytical laboratory.

In-Line Sediment Traps

Sediment traps will be inspected on a bi-monthly basis. If sufficient sediment has accumulated (e.g., greater than 500 mL), samples will be collected and the trap will be redeployed with a new, pre-cleaned sample container. If possible, samples will be collected after a period of three days of dry weather to allow for additional settling of particulate and colloidal materials. The sample containers will be removed from the sediment trap in a manner that will minimize resuspension of sediment and the height of sediment within the sample container will be measured to the nearest millimeter. The samples will be delivered directly to the analytical laboratory for processing in the original Teflon sample containers. Samples will be preserved according to PSEP guidelines (see Table 4).

Sample Containers, Preservation and Holding Times

Pre-cleaned sample containers will be supplied by the analytical laboratory for the required analyses. Spare sample containers will be carried by the field samplers in case of breakage or possible contamination. Sample containers, preservation techniques, and holding times will follow PSEP (1997) guidelines (see Table 4).

Sample Identification and Labeling

A unique site number (see Table 3) and the date of collection will identify each sample (e.g., ST1-032803-1 for the first sample collected from the sediment trap located at East Marginal Way on March 28, 2003). Prior to filling, sample containers will be labeled with the following information using indelible ink:

- Sample identification number
- Date of collection (day/month/year)
- Time of collection (military format)
- Project name (Diagonal)
- Analytes
- Sampler ID.

Labels on glass containers will be secured with adhesive tape.

Field Notes

When visiting the sampling station, field personnel will record the following information on field forms that are maintained in a waterproof field notebook.

- Date
- Time of sample collection or visit
- Name(s) of sampling personnel
- Weather conditions
- Number and type of samples collected
- Field measurements
- Log of photographs taken
- Deviations from sampling procedures
- Unusual conditions (e.g., water color or turbidity, presence of oil sheen, odors, and land disturbances).

For onsite catch basin samples, the following additional information will be recorded on the field form and field notebook:

- Map showing location of catch basin on the property
- Date site was inspected by Duwamish source control team
- Date the catch basin was last cleaned.

Upon return to the office, field notes will be copied and reviewed by the QA officer. Copies of field notes will be included in the final report.

Sample Transport and Custody

All samples will be transported on ice at 4°C in a cooler to the analytical laboratory. Samples will be hand delivered to the lab and stored in a refrigerator at 4°C. A chain-of-custody record will accompany the samples (see Appendix C). Upon return to the office, the QA officer will review a copy of the signed chain-of-custody record.

Field Duplicates

Field duplicates will be collected for each type of sediment sample at a minimum frequency of 5 percent (see Table 3). If sufficient sample volume exists, field duplicates will be collected for all sediment samples and archived (frozen) for future analysis if necessary.

Equipment Decontamination

All sampling equipment, including the sample bottles, Isco pump tubing, teflon suction tubing, and stainless-steel materials will be decontaminated prior to each sampling event. The following decontamination procedures will be followed after every sampling event:

Sediment Trap Sample Bottles

- Phosphate-free detergent wash and tap water rinse
- 10 percent ultra-pure hydrochloric acid rinse
- Reagent-grade water rinse
- Ultra-pure methanol rinse
- Air dry
- Cap on during transport to site.

Stainless-Steel Scoop and Mixing Bowl

- Phosphate-free detergent wash and tap water rinse
- Reagent-grade water rinse
- Ultra-pure methanol rinse
- Air dry
- Wrapped in new aluminum foil and bagged in plastic.

After the decontamination procedures have been completed, the sampling equipment will be capped or sealed with new aluminum foil and the sampling device will be protected and kept clean.

Laboratory Procedures

All samples will be analyzed by Analytical Resources, Inc. (ARI) with the exception that sediment grain size will be analyzed by Am Test Laboratories and low-level mercury in water will be analyzed by Brooks Rand, Ltd. ARI is certified by Ecology to perform the analyses listed in Table 4 and the methods used have been approved by EPA. The following quality control samples will be analyzed with each sample batch:

- Method blanks
- Laboratory duplicates (conventionals and metals only)
- Field duplicates
- Matrix spikes
- Matrix spike duplicates (organics only)
- Control standards
- Standard reference materials
- Surrogate spikes (organics only).

Sediment Trap Processing

Sediment trap samples will be delivered to the lab in the teflon field sampling containers. The lab will process the samples as follows prior to chemical analysis:

- Overlying water manually decanted, centrifuged, and saved for rinsing
- Sediment in field container transferred to appropriate containers
- Sediment remaining in field container rinsed with decant water and centrifuged.

Data Quality Assessment

The laboratories will report the analytical results within 30 days of receipt of the samples. Data will be checked for errors or omissions by the laboratory and the SPU QA officer. Sample and quality control data will be reported in a standard format. The laboratory reports will also include a case narrative that describes laboratory quality assurance results, any problems encountered in the analyses, and applicable data qualifiers.

The analytical results will be assessed by the laboratory and the QA officer in accordance with criteria described in the data quality objective section. Problems identified during these data assessments or through field and laboratory auditing will be addressed with corrective actions. Laboratory data will be checked for compliance with specified methods, holding times, reporting limits, and quality control criteria.

Implementing the QA procedures as described in previous sections will allow early detection of field data collection or laboratory analysis problems. Should problems arise, the project manager will be notified as to the nature and extent of the problem. A corrective action plan will be outlined to eliminate the problem. Once implemented, the effectiveness of the corrective action will be evaluated. Data problems, procedural problems, a description of the corrective action, and an evaluation of the effectiveness of the corrective action will be documented in the QA reports.

Data quality assessment procedures are described separately below for each quality control element.

Method Blanks

Method blanks, which are comprised of reagent-grade water, will be analyzed and the results will be presented in each laboratory report. Sample values less than 5 times a detected blank value will be considered estimates and flagged with a (B) qualifier.

Laboratory and Field Duplicates

Precision of laboratory duplicate and matrix spike duplicate results will be presented in each laboratory report and checked by the QA officer. Data for batch samples will be acceptable providing duplicates of project samples are analyzed at a frequency of at least 5 percent. Precision of laboratory, matrix spike, and field duplicate results will be calculated according to the following equation:

$$\mathrm{RPD} = \frac{100(C_1 - C_2)}{(C_1 + C_2)/2}$$

Where:

RPD = Relative standard deviation
C_1 = Larger of 2 values
C_2 = Smaller of 2 values

Laboratory and matrix spike duplicate results exceeding the precision objectives in Table 5 will be noted and flagged as estimates (J). If the objectives are severely exceeded (i.e., more than twice the objective), the associated values will be rejected (R). Field duplicate results will be used to evaluate both analytical precision and environmental variability, and may be used to flag data at the discretion of the QA officer.

Matrix and Surrogate Spikes

Matrix spike results will be presented in the laboratory report and checked by the QA officer. Data for batch samples will be acceptable providing spikes of project samples are analyzed at a frequency of at least 5 percent. Accuracy of matrix spikes will be calculated according to the following equation:

$$\%R = \frac{100(S - U)}{C_{sa}}$$

Where:

% R = Percent recovery
S = Measured concentration in spike sample
U = Measured concentration in unspiked sample
C_{sa} = Actual concentration of spike added.

If the analyte is not detected in the unspiked sample, then a value of zero will be used in the equation. The laboratory also analyzes surrogate spikes, and will include the results and control limits of these analyses in the laboratory reports.

Results exceeding the accuracy objectives in Table 5 will be noted and associated values will be flagged as estimates (J). However, if the matrix spike recovery exceeds 125 percent and a sample value is less than the reporting limit, the result will not be flagged as an estimate. Undetected values will be rejected if the percent recovery is less than 30 percent.

Control Standards

The accuracy of control standards will be reported in each laboratory report and checked by the QA officer. Accuracy for control standards will be calculated according to the following equation:

$$\%R = \frac{100(M - T)}{T}$$

Where:

%R = Percent recovery
M = Measured value
T = True value.

Results exceeding the accuracy objectives in Table 5 will be noted and associated values will be flagged as estimates (J). If the objectives are severely exceeded (e.g., more than twice the objective), then associated values will be rejected (R) and the analytical laboratory will be requested to reanalyze the samples.

Standard Reference Materials

Standard reference materials (SRM) are materials whose values are certified by a technically valid procedure and are accompanied by (or traceable to) a certificate or other documentation that is issued by a certifying body (e.g., National Institute of Standards and Technology [NIST]). The analytical laboratory will use NIST certified standard reference materials for sediment parameters and NIST traceable standards for water parameters. For sediments, the SRM used for PCBs and SVOCs is SQ-1 (Sequim Bay 1), for metals is ERA D034-540 (Trace Metals in Soil), and for TOC is NIST 8704. The SRM for water analyses is a NIST traceable standard. Results of the SRM analyses will be compared to action limits specified by the supplier to validate the accuracy of the analysis.

Completeness

Completeness will be assessed by comparing valid sample data that meet the data quality objectives and the chain-of-custody records. Completeness will be calculated by dividing the number of valid values by the total number of values. Samples will be reanalyzed or recollected if completeness is less than 95 percent.

Data Management and Reporting

All data collected as part of this project will be maintained on file by SPU. Copies of field notes, Isco sampler reports, and completed chain-of-custody forms will be submitted to the QA officer following each sampling event. The QA officer will review the field information to evaluate the following:

- Field notes to identify any unusual field conditions and/or deviations from the sampling protocol.
- Valid chain-of-custody documentation.

The analytical laboratories will submit a complete data package documenting the sampling results within 30 days of the date that samples were submitted to the laboratory. The data package will include the following:

- Sample results and explanation of data qualifiers.
- Results for all quality control analyses, including laboratory control standards, duplicates, matrix spikes/matrix spike duplicates, laboratory blanks, and surrogate recoveries (for organic analyses).
- Case narrative describing any analytical problems and corrective actions taken.

The QA officer will review the data package to determine whether data quality objectives were met. Deficiencies will be immediately reported to the analytical laboratory.

All sample results, including data qualifiers, sampling conditions, and field measurements will be entered into Excel spreadsheets.

A project report will be prepared that will present the laboratory reports, QA worksheets, chain-of-custody forms, copies of field notes, data analysis, and any problems and corrective actions taken. Sample results will be presented in tabular form, and will also be marked on a sample location map. Summary statistics of stormwater samples will be presented for both storm and base flow events, and will include:

- Number of samples analyzed
- Number of samples with detected chemical concentrations
- Arithmetic mean
- Median
- Minimum and maximum

- 10^{th} and 90^{th} percentiles
- 95 percent upper and lower confidence limits of the arithmetic mean and the median
- Standard deviation of the arithmetic mean
- Percent coefficient of variation.

For samples reporting non-detected concentrations, one-half the reporting limit will be used to calculate the summary statistics. Sediment sample results will be compared to sediment quality standards for marine sediments (WAC 173-204) because of the proximity of the outfall to the Duwamish Waterway, which is classified as a marine water body. Results for the organic parameters (PCBs and semivolatiles) will be normalized to organic carbon prior to comparisons with the sediment standards and historical data.

Catch basin sediment sample results will be compared to sediment criteria to evaluate areas that exceed sediment quality standards. Results will also be compared within catch basin areas to focus source control efforts. Both comparisons will help prioritize areas for agency business inspections.

In-line sediment and sediment trap sample results will be compared to each other to assess the variability of contamination between the different size fractions of sediment in the drainage system. In-line sediments will include large particle sizes (i.e., sands and gravels) while the sediment trap samples will be comprised of only finer sediment particles (i.e., clays and silts). Metals and organics tend to adsorb more readily to finer sediment particles than to larger particles due to the greater amount of charged surface area that exists on clay and silt particles.

In-line sediment and sediment trap data collected in subsequent years will be compared separately to the current results to evaluate the effectiveness of pollutant source control actions in the Diagonal basin. Non-parametric trend analysis will be used to determine if the levels of contamination are significantly different. In-line sediment data will also be compared to historical storm drain sediment data (Tetra Tech 2002).

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Appendix A

Appendix B